REMARKS

This paper is being provided in response to the Office Action mailed July 15, 2004, for the above-referenced application. In this response, Applicants have added new claim 9 and amended the specification for purposes of clarification. Applicants respectfully submit that the new claim is fully supported by the originally-filed application and that the amendments to the specification do not add new subject matter. Applicants submit the following remarks in response to the rejections set forth in the Office Action.

The objection to the specification for informalities has been addressed by amendments contained herein in accordance with the guidelines as set forth in the Office Action. Accordingly, Applicants respectfully request that this rejection be reconsidered and withdrawn.

The rejection of claims 1-8 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,523,410 to Matsubara et al. (hereinafter "Matsubara") in view of U.S. Patent No. 6,140,748 to Yang (hereinafter "Yang") is hereby traversed and reconsideration is respectfully requested.

Independent claim 1 recites a tuning fork crystal unit including a base and a pair of arms extending from respective ends of the base in a crystallographic Y direction or quartz crystal. Each of the arms comprise a first crystal member and a second crystal member which extend in the crystallographic Y direction, the first crystal member and the second crystal member being joined to each other in a crystallographic YZ plane by a direct bonding such that the first crystal member and the second crystal member have respective crystallographic X directions oriented

away from each other and extending parallel to each other. Claims 2-5 depend directly or indirectly in independent claim 1.

Independent claim 6 recites a bar type crystal unit extending in a crystallographic Y direction of quartz crystal. The unit includes a direct crystal member and a second crystal member which extend in the crystallographic Y direction. The first crystal member and the second crystal member are joined to each other in a crystallographic YZ plane by a direct bonding such that the first crystal member and the second crystal member have respective crystallographic X directions oriented away from each other and extending parallel to each other. Claims 7 and 8 depend directly or indirectly on independent claim 6.

The Matsubara reference discloses an angular rate sensor having two pieces of tuning fork type crystal units joined to each other in their crystallographic XY plane.

The Yang reference discloses a high voltage sensitivity Coriolis force driven piezoelectric transformer-gyroscope system and method of use. The Office Action cites Yang as disclosing that crystal members joined in both XY and YZ planes is an art recognized equivalent.

Applicants' present claimed invention recites that a tuning fork type and bar type crystal unit have a first crystal member and a second crystal member, wherein the first and second crystal members are *joined to each other in their crystallographic YZ plane by a direct bonding such that the first crystal member and the second crystal member have respective crystallographic X directions oriented away from each other and extending parallel to each*

other. Applicants have found that when an electric field is generated in this tuning fork type or bar type crystal unit by applying a potential to excitation electrodes on sides of each of the arms, i.e. exposed surfaces thereof in the crystallographic YZ plane, since the first crystal member and the second crystal member have their crystallographic X directions oriented away from each other, one of the first crystal member and the second crystal member is contracted while the other is expanded. Therefore, if the orientations of electric fields applied to both arms are appropriately selected, then the tuning fork crystal unit causes tuning fork vibrations in +/- X directions. The electric field in each arm extends parallel to the crystallographic X direction and is distributed substantially linearly. Therefore, the intensity of the electric field in each arm is increased. The tuning fork type crystal unit has a reduced crystal impedance, keeps its vibration characteristics well, and can be reduced in size. Only two excitation electrodes are needed for each arm of the tuning fork type crystal unit of the present claimed invention. (See page 4, line 19 to page 5, line 4 and page 9, lines 1-11 of the present application.)

Matsubara discloses that the two pieces of tuning fork type crystal units of an angular rate sensor are joined to each other in their crystallographic XY plane to efficiently excite vibration in the Z direction (which is perpendicular to the tuning fork plane of the sensor). (See Fig. 1 of Matsubara.) The Office Action notes that Matsubara does not disclose crystal members being joined in a crystallographic YZ plane. Applicants submit that the present claimed invention and Matsubara are different in the manner and configuration of the joining of the two crystal members and as to the vibration directions of the arms. As a result, the sensor of Matsubara arguably needs four excitation electrodes for each arm. Matsubara does not disclose first and second crystal members that are joined to each other in their crystallographic YZ plane by a

direct bonding such that the first crystal member and the second crystal member have respective crystallographic X directions oriented away from each other and extending parallel to each other, as claimed by Applicants.

Applicants respectfully submit that the Yang reference fails to overcome the above-noted deficiencies of Matsubara. Yang discloses a Coriolis force sensor using a piezoelectric material, such as ceramics, in which the orientation of the material is only represented by a polarization direction which is introduced to the material by "Polling procedure." (See col. 2, lines 50-61 of Yang.) Such a piezoelectric material used in Yang does not inherently have crystallographic axes because those piezoelectric members are formed by baking process of powder of the piezoelectric ceramic. Letters x1, x2 and x3 illustrated in FIG. 3 of Yang only represent longitudinal width and thickness directions of the piezoelectric member. These letters do not indicate crystallographic directions. Further, in FIG. 5b, Yang discloses a tuning-fork piezoelectric gyroscope system with each arm having oppositely oriented polarization direction materials disposed thereon and includes pairs of driving electrodes that sandwich the polarization direction materials. (See col. 9, lines 47 to col. 10, line 13 of Yang.) Applicants respectfully submit that Yang arguably does not disclose at least the features of first and second crystal members joined in the YZ plane and having *respective crystallographic X directions oriented away from each other and extending parallel to each other*, as is claimed by Applicants.

In view of the above, Applicants respectfully submit that the cited references do not teach or fairly suggest at least the above-noted features as claimed by Applicants. Specifically, neither Yang nor Matsubara, taken alone or in combination, disclose a crystal unit having a first crystal

member and a second crystal member, wherein the first and second crystal members are *joined to each other in their crystallographic YZ plane by a direct bonding such that the first crystal member and the second crystal member have respective crystallographic X directions oriented away from each other and extending parallel to each other.* Accordingly, Applicants respectfully request that this rejection be reconsidered and withdrawn.

Further, Applicants have added new claim 9 and respectfully submit that this claim is allowable over the cited prior art. (See page 7, lines 14-23 of the present application.) The present claimed invention provides a tuning fork crystal unit with a structure and electrode configuration, as recited above, such that when an alternating voltage is applied to the electrodes, the arms cause tuning-fork vibrations. Since electric fields along the X-axis are linearly applied, the tuning fork type crystal unit as recited has a higher electric field efficiency than conventional tuning fork type crystal units and demonstrates enhanced vibration characteristics and shock resistance capability. (See page 8, line 15 to page 9, line 11 of the present application.)

Based on the above, Applicants respectfully request that the Examiner reconsider and withdraw all outstanding rejections and objections. Favorable consideration and allowance are earnestly solicited. Should there be any questions after reviewing this paper, the Examiner is invited to contact the undersigned at 617-248-4038.

Respectfully submitted,
CHOATE, HALL & STEWART

Date: January 18, 2005

Elif E. Ca REG. No. 47,499
for: Donald W. Muirhead
Registration No. 33,978

Choate, Hall & Stewart
Exchange Place
53 State Street
Boston, MA 02109
Phone: (617) 248-5000
Fax: (617) 248-4000